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The Effect of Isolated Phlebectomy on Reflux and Diameter of the Great Saphenous Vein: A Prospective Study☆

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Phlebectomy;
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Abstract *Objectives:* To evaluate the effect of phlebectomy on venous reflux and diameter of the great saphenous vein (GSV).
Design: Prospective cohort study.
Method: Patients presenting with reflux in the GSV resulting in varicose veins were included in this series. Patients were treated by phlebectomy for dilated and incompetent tributaries of the GSV with conservation of the incompetent GSV. We measured reflux duration (RD), peak reflux velocity (PRV) and the diameter of the GSV using duplex ultrasound imaging at inclusion and 1 month after surgery.
Patients: We included 55 limbs in 54 patients (30 women and 24 men) aged from 37 to 83 (mean age 63) years.
Results: Following treatment we observed a significant reduction of the mean RD (0.81s vs. 1.5 s $p < 0.01$, *t*-test), mean PRV (120 mm s^{-1} vs. 249 mm s^{-1} $p < 0.01$, *t*-test) and mean diameter of the GSV (SFJ = 5.6 mm vs. 6.7 mm, $p < 0.01$, sub-terminal valve 4.8 mm vs. 4.4 mm $p < 0.05$, mid-thigh 5.0 mm vs. 4.2 mm, $p < 0.01$, knee 4.0 mm vs. 5.3 mm $p < 0.01$, mid-calf 2.7 mm vs. 4.0 mm, $p < 0.01$, *t*-test).
Conclusions: We noted reduced reflux in the GSV after phlebectomy with a significant reduction in RD and PRV. Phlebectomy also led to a significant reduction in GSV diameter. These data suggest that the haemodynamics and the diameter of the SV can be improved by using a treatment focussing on the saphenous tributaries.

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Introduction

Traditional views of the mechanism of development of varicose veins envisage a descending pathophysiological concept of superficial venous insufficiency (SVI) describing descending or retrograde venous reflux from the saphenofemoral junction (SFJ) to the saphenous trunk and collaterals.[1,2] A new concept has emerged in recent years which involves multifocal or ascending evolution from the suprafascial venous network to the saphenous trunk and then the SFJ.[3–9] Some authors have advanced the hypothesis that treatment limited to the ablation of the varicose reservoir (VR) of the suprafascial venous network can lead to the regression or elimination of saphenous reflux.[10–13]

The aim of this study is to investigate the haemodynamic and anatomical effects of isolated phlebectomies on reflux and the diameter of the great saphenous vein (GSV).

Materials and methods

This prospective study was conducted in one private surgical centre (Riviera Vein Institut in Nice). Two surgeons (PP and SC) participated in the study, in the same clinic. The assessment with duplex ultrasound imaging was done by the same physician (TL).

Population

This prospective longitudinal study included consecutive patients with varices arising from reflux in the GSV with or without reflux at the SFJ who presented at our clinic between 1 February and 31 March 2008. Dilated and incompetent tributaries of the GSV were managed by phlebectomy, with conservation of the incompetent GSV in accordance with the ambulatory selective varices ablation under local anaesthesia (ASVAL) method.[11,13] We excluded limbs where surgery or other treatment had already been done for varicose veins, limbs presenting with deep venous insufficiency, limbs with a competent GSV, limbs with reflux in both the small saphenous vein (SSV) and the GSV, limbs with a history of GSV thrombosis, limbs for which we considered GSV ablation was necessary for large diameter (>8 mm diameter) veins and patients with CEAP (Clinical, Etiology, Anatomy and Pathophysiology) clinical stage C5–C6 venous disease.

We looked for and recorded signs and non-specific symptoms of venous insufficiency (pain, heaviness, a swelling sensation, pruritus, night cramps, restlessness, tingling and warmth). The extent of the varices was evaluated according to the number of zones to be treated (NZT) by phlebectomy, with each limb divided into 32 zones during the pre-operative clinical mapping (Fig. 1). We performed the haemodynamic and anatomical measurements, as well as the clinical examination and recording of symptoms, at inclusion and 1 month after surgery.

Haemodynamic assessment

We measured reflux duration (RD) and peak reflux velocity (PRV) using continuous Doppler ultrasound performed with patients standing upright following a manual calf compression manoeuvre, except at the SFJ junction where we assessed the existence of reflux of the terminal valve of the GSV using a Valsalva manoeuvre. We made these measurements at the highest point where the reflux started. Reflux was considered to be pathological if RD was >0.5 s[14] We measured GSV diameter using ultrasound with the patient standing upright, at the SFJ (terminal valve), 3 cm distal to the SFJ (sub-terminal valve), in the middle third of the thigh (15 cm below the inguinal fold), at the knee and in the middle third of the calf (10 cm below the knee). The diameter of the GSV was carefully measured in a transverse image in the saphenous compartment. The measurement of the PRV, RD and saphenous diameter was repeated twice by the same operator (TL) and the mean calculated.

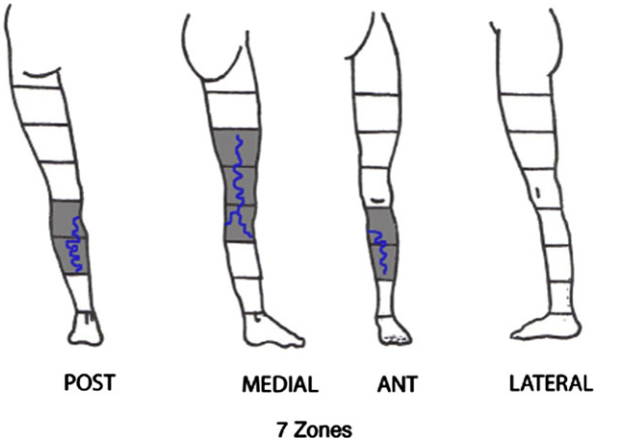

Figure 1 Pre-operative clinical mapping dividing the limb in 32 zones. Example of NZT = 7 NZT : number of zones to be treated.

Procedures

All the limbs were treated with ablation by phlebectomy of dilated incompetent tributaries of the GSV located preoperatively by ultrasound mapping, and with conservation of the refluxing GSV according to the ASVAL method.[11,13] We did not do a flush ligation of the varicose tributary related to the GSV, leaving a little stump, in order to avoid a tear or a ligation of the GSV. If the SFJ was competent, we did not ligate the incompetent perforator which fed the refluxing GSV, using the same strategy as that for patients with an incompetent SFJ.

The aim of the ASVAL method is to improve the haemodynamics of the GSV by ablation of dilated and refluxing tributaries of the GSV by phlebectomy, leading to the disappearance of saphenous reflux or at least a significant reduction of the reflux in duration, as has been previously reported.[11,13,15] This strategy of treatment is based on the ascending or multifocal theory of evolution of the SVI, which describes the beginning of varicose disease at the suprafascial network and not at the saphenous vein.[3–9] Saphenous reflux may appear secondarily by a 'filling effect' from VR, creating haemodynamic disturbance, which could explain the disappearance or the reduction of the reflux duration by suppression of the 'filling effect' after abolition of VR by phlebectomy.

Table 1 Pre-operative reflux localisation in the GSV.

	Number of limbs	%
Reflux starting from the terminal valve	20	36%
Reflux starting from the pre-terminal valve	25	45%
Reflux starting below the pre-terminal valve	10	18%
Presence of an incompetent perforator	7	
No incompetent perforator founded	3	
Total	55	

GSV: great saphenous vein.

All procedures were performed under tumescent local anaesthesia using isotonic bicarbonate for dilution (15 cc lidocaine 1% with epinephrine for 500 cc isotonic bicarbonate) on an outpatient basis. No additional sclerotherapy or endovenous thermal ablation was done during the surgical procedures. Post-operative compression was used for all limbs by the application of thigh-length French class 2 (18 mmHg) medical compression stockings during the day for 4 days. Walking was allowed and recommended immediately after surgery.

Statistical analysis

We have used the mean and standard deviation as descriptors for our data. Contingency table analysis was undertaken using the χ^2 test, and significance testing between means used Student's *t* test. Statistical analysis was performed using XLSTAT software (Addinsoft France, Paris, France). The significance level for all of the comparisons was set at 5%.

Results

A total of 138 patients with varices consulted our centre during the period of inclusion. Among these patients, 24 had recurrent varices, 40 had no reflux in the GSV, seven had been scheduled for GSV ablation, six had a reflux on both GSV and SSV in the same limb and seven patients refused surgical intervention. These patients were excluded from our study. We included 55 limbs in 54 patients who complied with the inclusion criteria. There were 30 women and 24 men with a mean age of 63 S.D. 2.7 years (range 37—83 years). The CEAP classification was assigned as follows: 43 were scored $C_2E_PA_{2,3,18}P_r$ (78%), two limbs $C_2E_PA_{2,3,17}P_r$ (4%) and 10 limbs were scored $C_2E_PA_{2,18}P_r$ (18%). Symptoms of venous disease (pain, heaviness, a swelling sensation, pruritus, night cramps, restlessness, tingling and warmth) were present in 45 limbs (82%). The patients' main reason for seeking treatment was for the presence of symptoms in 82%, a cosmetic problem in 13% and a desire to prevent worsening of the problem or a complication in 5%.

At review 1 month following surgery there was no post-operative complication. Return to normal activities (including work) was between 1 and 8 days (mean 2.2 S.D. 0.6 days).

Table 2 Haemodynamic evolution of the GSV after ASVAL procedure.

	Pre-operative	Post-operative	*P*
Significant GSV reflux	50 (100%)	20 (36%)	<0.001 (χ^2)
Significant SFJ reflux	20 (40%)	0 (0%)	<0.001 (χ^2)
Mean RD (s)	1.5 S.D. 0.2	0.81 S.D. 0.2	<0.001
Mean PRV (mm/s)	247 S.D. 40	120 S.D. 27	<0.001

GSV : great saphenous vein.
ASVAL : ambulatory selective varices ablation under local anaesthesia.
RD: reflux duration.
PRV: peak reflux velocity.

Doppler ultrasound characteristics

RD was >0.5 s in the GSV in all cases. The SFJ (terminal) valve was incompetent when assessed by a Valsalva manoeuvre in 20 cases (30%). The detailed pre-operative localisation of reflux in the GSV is described in Table 1. The RD and PRV are shown in Table 2. The diameter of the GSV at several levels is summarised in Table 3. The RD of the GSV reflux was less than 0.5 s in 64% of the cases, and greater than this in 36%. One month following treatment, we found no reflux at the SFJ in any patient. In addition, both the RD and the PRV decreased substantially (Tables 2 and 3).

Clinical outcome

All the limbs scored C0 or C1 for CEAP class C at the post-operative control visit after 1 month, and the limbs were asymptomatic in 40 cases (82%).

Influence of the presence of pre-operative terminal valve reflux >0.5 s

Comparison of limbs with significant pre-operative terminal valve reflux to those who had a competent terminal valve showed significant differences in age and diameters of the GSV at the SFJ, 3 cm distal to the SFJ and in the thigh.

Table 3 Changes in the diameter of the GSV after ASVAL procedure.

GSV mean diameter	Pre-operative (mm)	Post-operative (mm)	P — *t* test
Terminal valve (SFJ)	6.7 S.D. 0.6	5.6 S.D. 0.5	<0.01
Sub-terminal valve	5.4 S.D. 0.5	4.8 S.D. 0.3	<0.05
Middle third of the thigh	5.0 S.D. 0.4	4.2 S.D. 0.2	<0.01
Knee	5.3 S.D. 0.6	4.0 S.D. 0.3	<0.01
Middle third of the calf	4.0 S.D. 0.5	2.7 S.D. 0.2	<0.01

GSV: great saphenous vein.
ASVAL: ambulatory selective varices ablation under local anaesthesia.
RD: reflux duration.
PRV: peak reflux velocity.

Table 4 Pre-operative comparison of limbs presenting with or without significant SFJ reflux.

	Pre-operative SFJ incompetent	Pre-operative SFJ competent	P *t* test
Number of limbs	20	35	
Mean age (y)	68	57	<0.001
Presence of pre-operative symptoms	95%	74%	0.15 (χ^2)
Mean preop. GSV diameter (mm)			
Terminal	7.7	6.1	0.012
Sub-terminal	6.3	4.9	0.003
Middle third of the thigh	5.5	4.8	0.05
Knee	6.0	4.9	0.10
Middle third of the calf	4.3	3.9	0.37
Mean RD (s)	1.6	1.5	0.91
Mean PRV (mm/s)	291	225	0.12

GSV : great saphenous vein.
RD: reflux duration.
PRV: peak reflux velocity.

However, there was no difference in the mean diameter of the GSV at the knee or calf, or for the pre-operative RD and PRV or pre-operative symptoms (Table 4). Post-operatively there was a significant reduction of the GSV diameter, RD, PRV and the frequency of symptoms irrespective of the presence of pre-operative terminal valve reflux. The only factor that differed between the two groups post-operatively was the diameter of the GSV at the SFJ (Table 5).

Influence of persistent post-operative reflux with an RD > 0.5 s

Among the 20 limbs with a post-operative RD > 0.5 s, there was nonetheless a significant reduction in the mean GSV diameters, the mean RD and the mean PRV (Table 6). If we compare the group of 20 limbs presenting with an RD > 0.5 s post-operatively (group 1) and the group of 35 limbs presenting insignificant RD < 0.5 s post-operatively (group 2), the type of pre-operative reflux was different with regard to the distal extent of the reflux, while there was no significant difference between groups 1 and 2 in terms of the pre-operative frequency of terminal valve reflux. Although there was a very significant difference between groups 1 and 2 with respect to the mean pre-operative RD, there was no significant difference with regard to the mean pre-operative PRV. There was a significant difference between groups 1 and 2 with regard to the NZT, with a larger NZT in group 1. From a clinical point of view, there was no difference between groups 1 and 2 with respect to the absence of symptoms after 1 month (Table 7).

Discussion

A long time after the description of the technique of phlebectomy by Robert Muller[16] this prospective study showed that isolated phlebectomies had a significant effect on the characteristics of reflux in the GSV with a reduction in RD and PRV in the short term. In 64% of cases, there was

Table 5 Post-operative comparison of limbs presenting with or without pre-operative SFJ (terminal valve) reflux.

	Pre-operative SFJ incompetent	Pre-operative SFJ competent	P *t* test
Number of limbs	20	35	
Presence of post-operative symptoms	20%	17%	0.79 (χ^2)
Post-operative GSV diameter (mm)			
Terminal	6.4	5.2	0.02
Sub-terminal	5.1	4.7	0.22
Middle third of the thigh	4.2	4.2	0.79
Knee	4.2	3.9	0.48
Middle third of the calf	2.6	2.8	0.18
Mean RD (s)	0.8	0.8	0.80
Mean PRV (mm/s)	116	121	0.86

GSV: great saphenous vein.
RD: reflux duration.
PRV: peak reflux velocity.

Table 6 Modification of the diameter of the GSV and of the reflux characteristics after ASVAL procedure for limbs presenting persistent post-operative GSV reflux with RD > 0.5 s.

GSV mean diameter	Pre-operative	Post-operative	*P*
Post-operative GSV diameter (mm)			
Terminal	5.9	5.0	0.02
Sub-terminal	5.2	4.7	0.20
Middle third of the thigh	5.0	4.4	0.02
Knee	5.3	4.5	<0.001
Middle third of the calf	4.0	2.8	<0.001
Mean RD (s)	1.5	0.79	0.02
Mean PRV (mm/s)	248	117	<0.001

GSV: great saphenous vein.
ASVAL: ambulatory selective varices ablation under local anaesthesia.
RD: reflux duration.
PRV: peak reflux velocity.

no longer any significant reflux in the GSV and terminal valve reflux had been eliminated as assessed by a Valsalva manoeuvre. We also noted a significant reduction in the diameter of the GSV at all levels measured. However, the time of the examination and the outside temperature were not recorded in our study and these factors may have influenced the haemodynamic measurements.

The disappearance of significant reflux from the GSV following phlebectomy or after ablation of an incompetent tributary has already been reported in the literature,[10–13,15] as has the reduction in the diameter of the GSV after ablation of a refluxing collateral.[13,17] Such reversibility of the GSV reflux was reported by Fegan a long time ago following compression sclerotherapy.[18] On the other hand, in these studies, detailed measurements of reflux duration and velocity were not done. It is interesting to note that even when reflux persisted beyond 0.5 s, there was still a significant reduction in both the velocity and duration of reflux, and also in the diameter of the GSV after ablation of the VR by means of a phlebectomy. Furthermore, in our study there was no significant difference in terms of symptom improvement regardless of whether saphenous reflux remained after phlebectomy. This also raises a question about the value of the 0.5 s threshold which defines reflux as pathological,[14] because duration is only one element of reflux.

We found an association between the presence of terminal valve (SFJ) reflux and a greater diameter of the GSV at the junction and also with increasing age. These observations have been made previously in other studies.[19,8,9] However, the presence of a terminal valve reflux did not influence haemodynamic changes after phlebectomy, perhaps because all these patients were affected by mild venous disease (CEAP clinical stage C2).

Table 7 Comparison of limbs with or without persistent post-operative GSV reflux with RD > 0.5 s.

	Presence of post-operative GSV reflux (RD > 0.5 s)	Absence of significant post-operative GSV reflux	*P*
Number of limbs	20	35	
Pre-operative GSV reflux reaching the middle third of the calf	100%	15%	<0.001 (χ2)
Pre-operative GSV reflux reaching the malleolus	25%	0%	0.002 (χ2)
Pre-operative trans-terminal reflux	25%	43%	0.35 (χ^2)
Mean RD (s)	2.5	0.99	<0.001
Mean PRV (mm/s)	266	237	0.45
Mean NZT	7.1	5.8	0.02
Absence of post-operative symptoms	75%	83%	0.81 (χ^2)

GSV: great saphenous vein.
ASVAL: ambulatory selective varices ablation under local anaesthesia.
RD: reflux duration.
PRV: peak reflux velocity.
NZT: number of zones treated by phlebectomy.

If we integrate the Doppler reflux curve with duration on the *x*-axis and the velocity on the *y*-axis, we get the distance covered, and if we relate this distance to the diameter of the vein at the point where the reflux is studied, we obtain the reflux volume. Some authors have stated that the reflux volume is important to the clinical severity of venous insufficiency. Colignon[20] has reported a prospective study which showed that there was a correlation between the reflux volume in the GSV and the CEAP clinical stage. In our study we found that, regardless of whether the RD remained above 0.5 s, the reduction in the duration and velocity of reflux associated with the significant reduction in the diameter of the GSV led to a significant reduction in the reflux volume. We also recorded improvement in symptoms.

Other publications[21–23] have reported a correlation between plethysmographic criteria and a clinical or haemodynamic improvement measured using Doppler ultrasound, highlighting the role that reflux volume plays in the development of venous insufficiency. Phlebectomies probably reduce the reflux volume explaining the clinical and haemodynamic improvements, even if the reflux remains above 0.5 s. The group of limbs where reflux persisted above the 0.5 s threshold post-phlebectomy had a less extensive NZT and therefore a smaller pre-operative VR. We have already reported that the haemodynamic and clinical improvement after phlebectomy and conservation of a refluxing SV (ASVAL method[11]) was correlated with the size of the VR treated[13] and therefore with the refluxing volume eliminated. The larger the treated VR, the more clinical and haemodynamic modifications are caused. In addition, we had reported in the same study[13] that the recurrences observed during the 4 years of follow-up after phlebectomy were accompanied by the absence of saphenous reflux in 17 out of 24 cases, suggesting an evolution of the varicose recurrence from the suprafascial venous network, unrelated to any persistent or recurrent SV reflux. Similarly, the majority of recurrent varices appeared after endovenous ablation of the GSV despite the obliteration of the saphenous vein.[24,25] These observations and our findings showing the effect of the ablation of the VR on the saphenous haemodynamics support the ascending theory of SVI evolution, as the VR is at the centre of the physiopathology and saphenous reflux is just one consequence of the VR that the refluxing volume depends on.

The extent of reflux along the GSV appears to have an effect on the results of the phlebectomy: the presence of reflux below the knee and especially reaching the malleolus was much more frequently found in the group of limbs with persisting reflux longer than 0.5 s post-phlebectomy. The correlation between clinical stage and the scale of the reflux is described in previous publications.[9,26–29] We have also reported the harmful effect that pre-operative reflux extending from the SFJ to the malleolus has on the haemodynamic evolution of the SV after the phlebectomy.[13] When SV reflux reaches the malleolus, there is less expectation of an improvement in this reflux, because the option of treating underlying VR causing a filling effect is no longer available. Finally, the observation of a larger reduction in the post-operative diameter of the distal GSV could signify that the distal GSV has a greater capacity to reduce its diameter after phlebectomy, although this has not been found in previous studies.

Conclusion

We measured a change in reflux characteristics of the GSV in the short term after isolated phlebectomies, with a significant reduction in RD and PRV. Isolated phlebectomies also led to a significant reduction in GSV diameter. The combination of haemodynamic and anatomical modifications led to a reduction in reflux volume. Our results suggested that the reflux volume could be the key element explaining the haemodynamic and clinical consequences of treatment of the varicose reservoir, and beyond this, could help us understand the clinical importance of venous reflux.

Longer-term follow-up of the cohort from this study will enable us to check this correlation in terms of clinical and haemodynamic evolution. In addition, other studies are required to confirm if reflux volume is correlated to the clinical consequences of the reflux.

Conflict of interest

No personal or financial conflict of interest to disclose.

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